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K. L. Warsop

1 August 1968

SUN 143-10

Solventless [Extruded] Powder [N-5] - General.

EVALUATION OF AN IMPROVED SHIPPING  
CONTAINER FOR MK 43 MOD 1 PROPELLANT GRAINS

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K. L. Warsop  
Author

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TABLE OF CONTENTS

	<u>PAGE</u>
DIGEST . . . . .	i
INTRODUCTION . . . . .	1
DISCUSSION OF RESULTS . . . . .	2
MATERIAL PROCUREMENT . . . . .	2
RECEIPT OF MATERIALS . . . . .	4
PACKING OF UNITIZED PACKAGES . . . . .	4
MAGAZINE STORAGE . . . . .	5
CONCLUSIONS AND RECOMMENDATIONS . . . . .	8
FIGURES	
I. ECONOMIC ANALYSIS -- MK 43 PACKAGING . . . . .	10
II. LOADING AND INSPECTION OF PROTOTYPE UNIT . . . . .	12
III. BOX ASSEMBLY AND PACKING -- UOP . . . . .	13
IV. PACKING OF MK 43 MOD 1 GRAINS . . . . .	14
V. MAGAZINE STORAGE . . . . .	15
VI. DAMAGED TOP TRAY . . . . .	16
VII. MAGAZINE STORAGE -- TIERED THREE HIGH . . . . .	17
VIII. SUNFLOWER AAP EXPENDITURES . . . . .	18
DISTRIBUTION LIST . . . . .	19

HERCULES INCORPORATED  
SUNFLOWER ARMY AMMUNITION PLANT  
LAWRENCE, KANSAS

TECHNICAL DEPARTMENT INVESTIGATION REPORT

K. L. Warsop

SUN 143-10

1 August 1968

Solventless /Extruded/ Powder /N-5/ - General

EVALUATION OF AN IMPROVED SHIPPING  
CONTAINER FOR MK 43 MOD 1 PROPELLANT GRAINS

DIGEST

Preliminary design and test work was conducted at Sunflower Army Ammunition Plant under Project No. OAC 55-298-KT-240, funded June 20, 1955, on a non-returnable fiberboard palletized shipping container for the MK 43 propellant grain. Evaluation of the proposed design was never completed due to cessation of operations in late 1956. In February, 1968, the Naval Weapons Handling Laboratory, Earle, New Jersey, again funded Sunflower Army Ammunition Plant to complete the evaluation of the proposed design in the hope of implementing the use of this shipping container between the manufacturing and loading plants during the current operation.

A program plan calling for shipment of 48 unitized packages (approximately 12,000 MK 43 grains) was submitted and approved. After preliminary dimensional check-out of a prototype unit, the required

components and tooling were procured. On April 1 and April 2, 1968, propellant grains from current production (SUN Lot 6937) were packed without incident and placed in magazine storage to await normal shipment to the loading plant. During the on-plant trial loading and transporting, the predicted labor savings was observed and verified.

The loaded fiberboard containers were tiered two high during magazine storage for one month and were then tiered three high to simulate storage conditions at the loading plants. During final preparation for shipment, Sunflower Army Ammunition Plant was notified that "All experimentation on the fiberboard inter-plant shipping container for MK 43 grains will cease". Authority for this cessation of activity was AMC TWX from the 2.75" Rocket System Project Manager to APSA dated 23 April 1968. Subsequently, the grains were unpacked and repacked in the specified container for shipment to the loading plant.

Although the premature cancellation of the proposed work did not allow complete evaluation of the fiberboard container, observations made during the packing and storage operations on plant were very encouraging. The potential for reduced labor requirements was verified and no major operating or storage problems were observed. If evaluation had been successfully completed, an annual savings of approximately \$480,000 would have been realized in labor and freight costs at Sunflower Army Ammunition Plant.

K. L. Warsop

SUN 143-10

1 August 1968

### INTRODUCTION

Development of an improved shipping container for MK 43 Mod 1 propellant grains was initiated at Sunflower Army Ammunition Plant under OAC Project No. 55-298 KT-240, funded June 20, 1955. During the early design stages of the fiberboard unitized shipping container, extensive laboratory tests were performed. The tests indicated that the proposed pack would satisfactorily withstand the stresses encountered both in shipment by rail or motor vehicle and when tiered three or four high in storage. Also, the Bureau of Explosives was contacted to confirm that shipment of propellant grains in this type of packaging was permissible. At that time, no objection was voiced to the general method outlined provided that certain changes were incorporated in the design package. These changes were implemented and are reflected in the present design. The above effort was actively pursued until Naval Speedletter of 11 September 1956 proposed that Sunflower concentrate on the present package due to reduced Navy requirements for small caliber rockets.

Because of the significant annual costs savings (See Figure I), the contractor again actively pursued implementation of the "Improved MK 43 Propellant Grain Fiberboard Unitized Package".

Preliminary evaluation began when one sample unit of the proposed fiberboard unitized package was obtained and loaded to check

K. L. Warsop

SUN 143-10

1 August 1968

dimensional tolerances. Trial loading was accomplished on 17 November 1967 (See Figure II), and no dimensional problems were observed.

In February, 1968, Sunflower Army Ammunition Plant was funded by the Navy to conduct a trial shipment of 48 unit loads (UL). The shipment was to move by trailer on flat car (TOFC) to the loading facility at Camden, Arkansas. Bureau of Explosives Approval No. 746, covering packaging and palletization and mode of transportation, was assigned to this project. A program plan was prepared describing the activities required to accomplish an adequate evaluation of each phase of the trial shipment and transmitted to all interested activities.

Actual evaluation began on 28 February 1968 and progressed through the packing operation on schedule without unusual incident. The unit loads were placed in magazine storage on 2 April 1968 to await scheduled shipment to Baldwin Electronics Plant. Official notification of termination of the program was received at Sunflower Army Ammunition Plant on 24 April 1968. Direction was given to unpack the propellant grains and repack them in the present container.

#### DISCUSSION OF RESULTS

##### a. Material Procurement

All parts necessary for assembly of 48 unitized packages were procured per the list of drawings and specifications on MHL

Drawing No. 2165. Deviations from applicable drawings (approved by NWHL) are noted below:

1. Trays - Top and Bottom - MHL Drawing No. 2160

To reduce assembly time and costs at Sunflower Army Ammunition Plant, the corrugated supplier assembled the trays and scored the corners, thus allowing the package to be shipped in a "knocked-down" condition.

2. Inner Liner - MHL Drawing No. 2163 and Master Partition - MHL Drawing No. 2161

Because of availability and cost, the corrugated supplier furnished C/B flute double wall corrugated fiberboard in lieu of the drawing call-out for A/B flute double wall corrugated fiberboard. This substitution was concurred with by NWHL, provided that the overall dimensional tolerances conform to drawing specifications. The primary difference between the two materials is that: (1) the C/B flute material contains more flutes per inch; (2) the flute height is less; and (3) the wall thickness is somewhat less than the A/B flute material. The difference in wall thickness was not significant enough to affect drawing tolerances because C/B flute material was supplied for the prototype unit which was checked dimensionally and found acceptable.

3. Expendable Pallet - BUMEPS Drawing No. 1350881

The pallet supplier took exception to "all lumber shall be undressed or bandsaw finished" because of the  $3/8 \pm 1/16$ "



K. L. Warsop

SUN 143-10

1 August 1968

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thickness requirement for the top and bottom deck boards. Authorization was given to plane the deck boards to the required thickness, providing the finish is equivalent to or better than the undressed or bandsaw finish.

b. Receipt of Materials

All component parts, miscellaneous parts, and tooling necessary for assembly of 46 unitized packages were received ahead of schedule.

For convenience of the box assembly and packing operation, the corrugated supplier packaged all fiberboard parts for a complete assembly in individual packages. Five individual packages were then banded into a 5-pack for shipment. This method of packaging caused some concern in that the individual parts were more susceptible to damage. Slight damage occurred, most frequently to the trays and liners, but was not severe enough that the parts were unusable. All component parts were given a count and condition inspection upon receipt. All fiberboard parts for one assembly and one pallet were selected at random and visually and dimensionally inspected. These parts were then assembled and the completed unit was visually and dimensionally inspected. Inspection results showed no deviation from drawing requirements.

c. Packing of Unitized Packages

A temporary unit operating procedure for the box assembly and

K. L. Warsop

SUN 143-10

1 August 1968

packing operation was prepared and approved on 27 March 1968 (See Figure III).

The packing operation began the 8-4 shift on 1 April 1968 and was completed the 8-4 shift on 2 April 1968. Fourteen units were packed on the first shift, 10 units on the 4-12 shift, 15 units on the 12-8, and 9 units on the 8-4 shift on 2 April 1968, for a total of 48 units. Each unit contained 252 MK 43 Mod 1 grains, for a 48 unit total of 12,096 grains. These grains represented a segment of SUN Lot 6937 which contained 19,875 grains, the remainder of which were packed in the MK 2 palletainers and MK 10 packing tubes.

Pallets and fiberboard parts were delivered to the line as needed. The fiberboard units were assembled in an adjacent room and transported by jack to the designated areas for packing. As the unit loads were packed (See Figure IV) and banded, they were moved by a semi-open-bedded truck to the magazine for storage. The packing operation ran very smoothly with no unusual incidents. Some problem was experienced with obtaining the desired strap tension. As the operators became familiar with the combination stretcher and seal tool, obtaining desirable strap tension was no problem.

d. Magazine Storage

The unit loads were transported from box pack to the magazine area by a semi-open-bedded truck; i.e., the bed contained three sides

K. L. Warson

SUN 143-10

1 August 1968

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and a top which covered one-third of the bed. These trucks are equipped with a tarp which is attached to the side of the bed adjacent to the cab. Since it rained throughout the majority of the 12-8 shift, it was necessary to use the tarps to keep the fiberboard containers dry. The tarps proved very satisfactory and no problem was encountered with wet containers.

As the fiberboard containers arrived at the magazine, they were tiered two high for storage (See Figure V). On the 12-8 shift, one container was damaged (See Figure VI) to the extent that it was returned to box pack. The damage occurred during the tiering operation. A container which was being placed on the top tier was lowered too quickly and then pushed into the desired position. This resulted in the damage seen in Figure VI which was caused by the wooden pallet as it slid across the top tray. When the damaged container arrived at box pack, it was unbanded, grain condition checked, the damaged tray replaced, and the container returned to the magazine. The propellant was adequately protected by the inner and outer liners because the damage occurred on the edge of the tray near the corner.

A temperature/humidity recorder was placed in the magazine on 3 April 1968. The records show the following weekly averages of the daily high and low for both temperature and relative humidity.

K. L. Warsaw

SUN 143-10

1 August 1968

<u>Time Span</u>	<u>Weekly Average of Daily High &amp; Low</u>			
	<u>Temperature</u>		<u>Humidity</u>	
	<u>High</u>	<u>Low</u>	<u>High</u>	<u>Low</u>
3 April - 9 April	61	50	82	75
9 April - 16 April	67	55	83	70
16 April - 23 April	68	57	95	84
23 April - 30 April	66	53	81	72
30 April - 7 May	76	62	78	64
7 May - 14 May	69	59	85	75
14 May - 21 May	74	61	81	68

After one month in magazine storage, the fiberboard containers showed no sign of moisture absorption or structural inadequacies. A top tray on one container had water standing on it while in the magazine due to a leak in the roof. On 1 May 1968 (after approximately one month in storage), this container and a container that had been banged on the corner near the bottom tray were taken to box pack and unloaded. The grains in the container that had received a hard impact showed no evidence of damage. Again the two liners provided more than adequate protection against damage. This container also had a unit stacked on top of it while in magazine storage. The fiberboard parts showed no visible evidence of structural deterioration. The grains in the "wet container" were also in good condition as the water did not penetrate the fiberboard.

K. L. Warsop

SUN 143-10

1 August 1968

Most of the pallet deck boards between the posts show evidence of sagging. This sagging condition had no adverse effects on the container or its contents.

On 1 May 1968, the fiberboard containers were tiered three high (See Figure VII). The containers were stored in this manner until final disposition. As evidenced by Figure VII, required storage space is reduced significantly. Until the time of unpacking and repacking in the MK 10/MK 2 container on 23 May 1968 and 24 May 1968, no visual evidence of container deterioration was noted. Grains were carefully inspected during the repacking operation and no grain damage was noted.

#### CONCLUSIONS AND RECOMMENDATIONS

The shipping container described on MHL Drawing 2165 would be satisfactory as a method of packaging and storing MK 43 Mod 1 propellant grains prior to shipment to a loading facility.

A real labor and freight savings is available if this improved container was approved for use.

No conclusion can be drawn as to the suitability of this container to over-the-road shipment or loading plant conditions due to the premature termination of the evaluation program.



K. L. Warsop

SUN 143-10

1 August 1968

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Should any further work be done on this container design, it is recommended that the drawings be revised as follows:

- a. MHL Drawing No. 2160 - Top and bottom trays to be assembled by the corrugated supplier and the corners scored, thus allowing the package to be shipped in a "knocked-down" condition.
- b. MHL Drawing Nos. 2161 and 2163 - Substitute C/B flute material for A/B flute material for the Inner Liner and Master Partition.
- c. BUNEPS Drawing No. 1350881 - Top and bottom deck boards may be undressed, bandsaw finished, or planed to the required thickness.

K. I. Warsop

SUN 143-10

1 August 1968

FIGURE I

ECONOMIC ANALYSIS  
MARK 43 PACKAGING  
(BASED ON 300,000 MARK 43 GRAINS/MONTH)

	<u>Present Method</u>	<u>Proposed (Unitized Package) Method</u>
<b>I. Bases for Cost Comparison</b>		
<b>A. Weights, lb.</b>		
1. MK 2 Pallet Crate	245	-
2. MK 10 Grain Container	2.25	-
3. Filler Block	1.5	-
4. Box	-	56
5. Pallet	-	40
6. Strapping and Guards	-	4
7. Total Tare Weight	742	100
8. Tare Weight Per MK 43 Grain	3.373	0.397
9. Finished MK 43 Grain, each	6.375	6.375
<b>B. Volumes, Cubic Feet</b>		
1. MK 2 Pallet Crate	56.8	-
2. Unitized Package	-	39.7
<b>C. Capacities</b>		
1. MK 43 Grains Per Container	220	252
2. Grain Containers Per TOFC* Trailer	18	24
<b>D. Costs</b>		
1. Containers:		
a. MK 10 Grain Container, \$/pc.	0.44	-
b. Filler Block for Pallet Crate, \$/pc.	0.26	-
c. Unitized Package, Complete, \$/pc.	-	13.03
2. Freight (TOFC), \$ Per CWT		
a. To Camden, Arkansas	0.95	0.95
b. From Camden, Arkansas	1.22	1.22

\*TOFC = Trailer on Flat Car

K. L. Warsop

SUN 143-10

1 August 1968

FIGURE I (Continued)

ECONOMIC ANALYSIS  
MARK 43 PACKAGING  
(BASED ON 300,000 MARK 43 GRAINS/MONTH)

	<u>Present Method</u>	<u>Proposed (Unitized Package) Method</u>
II. Cost Comparison, Dollars Per Month**		
A. Labor		
1. Production Department	22,300	9,000
2. Stores Department	12,800	500
3. Fringe Benefits (23%) on Labor	8,100	2,200
B. Material	3,600	15,500
C. Freight	<u>21,900</u>	<u>1,100</u>
D. Total Costs	68,700	28,300
E. Cost Per MK 43 Grain Shipped	0.229	0.094
III. Savings		
A. Per Year (\$68,700 - \$28,300) • 12	\$484,800	
B. Minus Implementation Costs		
1. Evaluation Program (See Figure VIII)	\$ 4,800	
2. Strapping Equipment (2 @ \$200 each)	\$ 400	
C. Net (First Year) Savings	<u>\$479,600</u>	

\*\*Calculated to the nearest one hundred dollars





FIGURE II

FIGURE III

-13-

HERCULES INCORPORATED  
SUNFLOWER ARMY AMMUNITION PLANT  
LAWRENCE, KANSAS

TEMPORARY

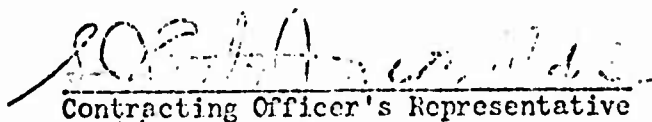
SUNFLOWER OPERATIONS MANUAL

PROCEDURE NO. UOP 5-1-'531 REV. 0

TITLE: PACKING PROPELLANT GRAINS

(This procedure is only valid for 90 days  
from date of approval)

Approved by:

  
Contracting Officer's Representative

MAR 27 1968

  
B. Talley, Manager

HERCULES INCORPORATED  
SUNFLOWER ARMY AMMUNITION PLANT  
PRODUCTION DEPARTMENT  
UNIT OPERATING PROCEDURE

AREA & BUILDING: FINISHING AREA - BUILDINGS 6817-1 AND 6817-3  
TASK: ASSEMBLY, PACKING AND BANDING OF FIBERBOARD UNITIZED  
SHIPPING CONTAINER  
TITLE: PACKING PROPELLANT GRAINS

PROCEDURE NO. UOP 5-1-1531 REV. 0 TOTAL PAGES 4

HAZARDOUS

This document supersedes None.

1 SCOPE

- 1.1 This procedure outlines the minimum requirements for the safe and efficient operation of the Pack House in packing of propellant.

2 REQUIREMENTS

- 2.1 All persons operating and supervising the operation of the Pack House are required to know, and to observe this Temporary Unit Operating Procedure, UOP 5-1-1531, "Packing Propellant Grains."
- 2.2 General Operating Procedure, GOP 5-1-1307, "Packing and Unpacking Propellant Grains", shall also be read, understood, and followed.
- 2.3 All instructions in this procedure are applicable to operations performed in Building(s) 6817-1 and 6817-3. Other approved instructions issued for the safety of personnel and/or the efficiency of the operation are also applicable.
- 2.4 An operating record shall be kept of operations performed within the Control Unit.
- 2.5 General safety rules for Sunflower Army Ammunition Plant shall be observed.
- 2.6 Should any condition arise not covered by this Unit Operating Procedure, or if procedure is not understood clearly, the operating supervisor shall be consulted.

3 APPLICABLE DOCUMENTS

- a. GOP 5-1-1307  
b. BUORD DWG. No. MHL 2159 Packaging and palletizing - General arrangement.  
c. BUORD DWG. No. 656706 Propellant Grain, MK 43, MOD 1 Assembly
4. MATERIALS AND EQUIPMENT

Date MMR 27 1968

HERCULES INCORPORATED  
SUNFLOWER ARMY AMMUNITION PLANT  
PRODUCTION DEPARTMENT  
UNIT OPERATING PROCEDURE (Cont.)

PROCEDURE NO. UOP 5-1-1531

TITLE: PACKING PROPELLANT GRAINS

- 4.1 Refer to GOP 5-1-1307 for listing of approved tools, materials, and equipment.

5 SAFETY

- 5.1 Safety Rules and Precautions outlined in GOP 5-1-1307 shall be observed.

6 OPERATIONS

NOTE: Referenced drawings listed are located in the Quality Control Area Office.

6.1 RECEIPT OF PROPELLANT

- 6.1.1 Position the loaded skids in the designated locations.  
6.1.2 Working Group Leader shall check each skid for the proper Lot identification.

6.2 PREPARING THE FIBERBOARD UNITIZED PACKAGE

NOTE: Packages containing a complete unit and wooden pallets will be delivered by the Warehouse.

- 6.2.1 Obtain a pallet and position it in the designated area under sprinkler protection.  
6.2.2 Obtain a package, containing a complete unit, for each pallet.

NOTE: Each package contains the following parts: two (2) trays (top and bottom; both are identical), one (1) outer liner, one (1) inner liner, one (1) master partition (consisting of two (2) pieces), and four (4) slotted partitions (consisting of fifty-six (56) pieces each, assembled).

- 6.2.3 Take a tray from the package and position it squarely on the pallet.  
6.2.4 Place the outer liner in the tray, then place the inner liner inside the outer liner, assuring that both the outer and inner liners are firmly in contact with the bottom of the tray.  
6.2.5 Next, assemble the master partition (consisting of two (2) slotted pieces) and place it inside the fiberboard container.

Date MAR 17 1968

FOR APPROVAL

HERCULES INCORPORATED  
SUNFLOWER ARMY AMMUNITION PLANT  
PRODUCTION DEPARTMENT  
UNIT OPERATING PROCEDURE (Cont.)

PROCEDURE NO. UOP 5-1-1531

TITLE: PACKING PROPELLANT GRAINS

- 6.2.6 Place a slotted partition (assembled) in each of the four sections formed by the master partition.

NOTE: The shipping container is now prepared for packing.

6.3 PACKING OF PROPELLANT

- 6.3.1 Remove the grains from the skid(s) and lower the grains (A-end down, sleeve end up) carefully into the receiving slots or holes formed by the slotted partitions. Each shipping package contains 252 slots for 252 grains.

- 6.3.1.1 Visually inspect all grains for obvious critical defects while placing grains in the shipping container.

- 6.3.2 Obtain the tray remaining in the assembly package and place it on top of the packed unit.

- 6.3.3 Stencil the required data on the shipping container in the designated locations.

NOTE: The shipping container is now ready for banding.

6.4 BANDING THE FIBERBOARD UNITIZED SHIPPING CONTAINER

NOTE: Strapping will be applied to the width first.

- 6.4.1 Obtain two (2) edge protectors and center them between the imprinted guide lines located on each side of the top tray.

- 6.4.2 Place the strapping around the shipping container, threading it between the top and bottom decks of the pallet. Assure that the strapping is centered on the edge protectors and between the guide lines on the bottom tray.

- 6.4.3 Insert both straps into the "combination stretcher-sealer tool", with the tool positioned in the approximate center of the tray.

- 6.4.4 Apply tension to the straps until a slight wrinkle appears in the top tray (cover).

Date APR 27 1968

HERCULES INCORPORATED  
SUNFLOWER ARY AMMUNITION PLANT  
PRODUCTION DEPARTMENT  
UNIT OPERATING PROCEDURE (Cont.)

PROCEDURE NO. UOP 5-1-1531

TITLE: PACKING PROPELLANT GRAINS

6.4.4 Continued

NOTE: Before applying final tension, assure that strapping is centered on edge protectors and between guide lines.

6.4.4.1 Affix one (1) seal to the straps by double crimping.

6.4.5 Repeat Steps 6.4.1 through 6.4.4 and Substep 6.4.4.1 for the remaining strap to be applied to the width and for the two straps to be applied to the length of the shipping container.

6.4.6 Move the completed shipping container onto the truck.

CAUTION: Use extreme caution when preparing the container for and during movement to the truck to prevent damage to the fiberboard container and the wooden pallet.

6.4.7 Repeat Steps 6.2.1 through 6.4.6 as required for continuous operation.

6.4.8 Notify the Working Group Leader as each truck is loaded.

Date

MAR 27 1968



FIGURE IV





FIGURE V



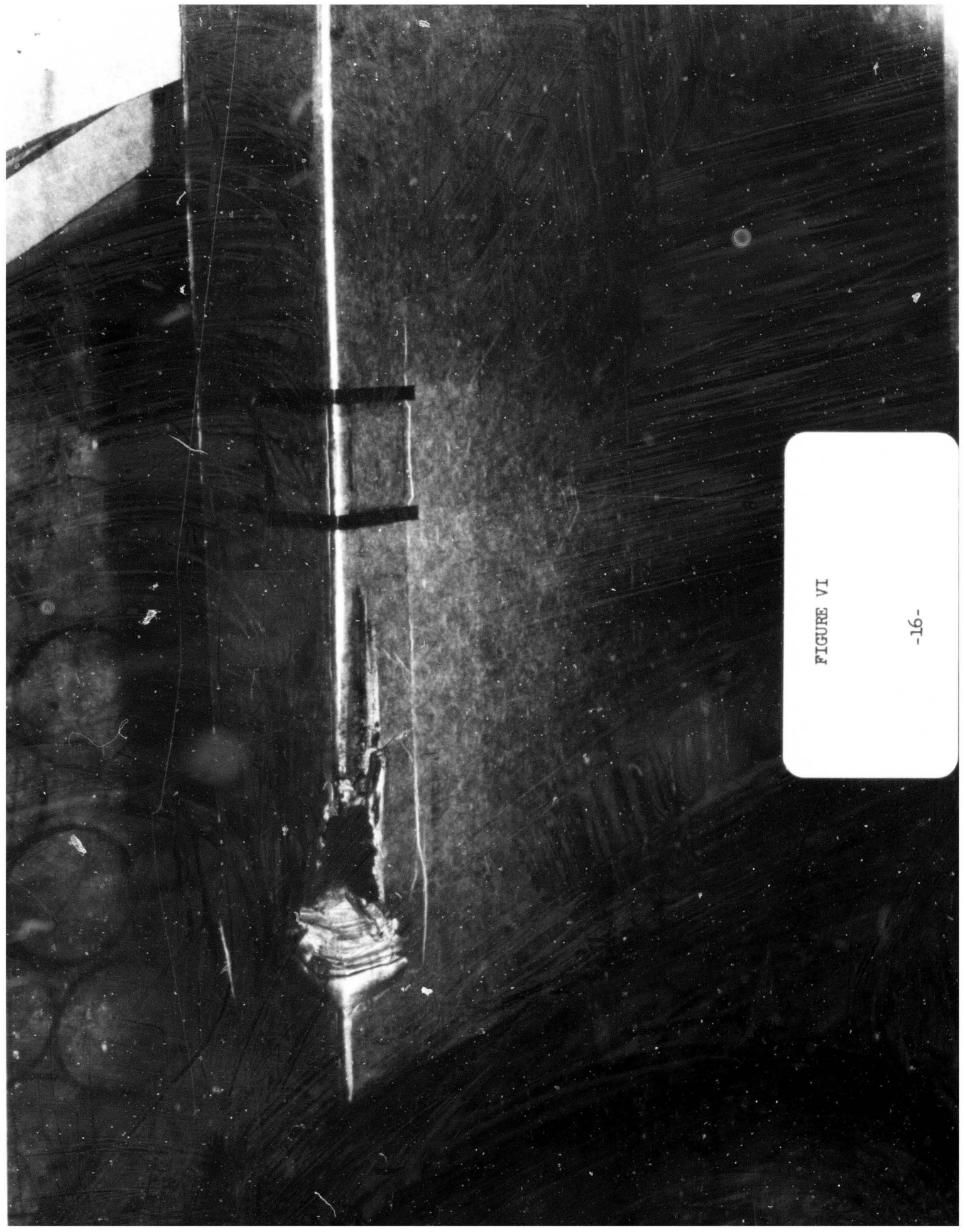


FIGURE VI

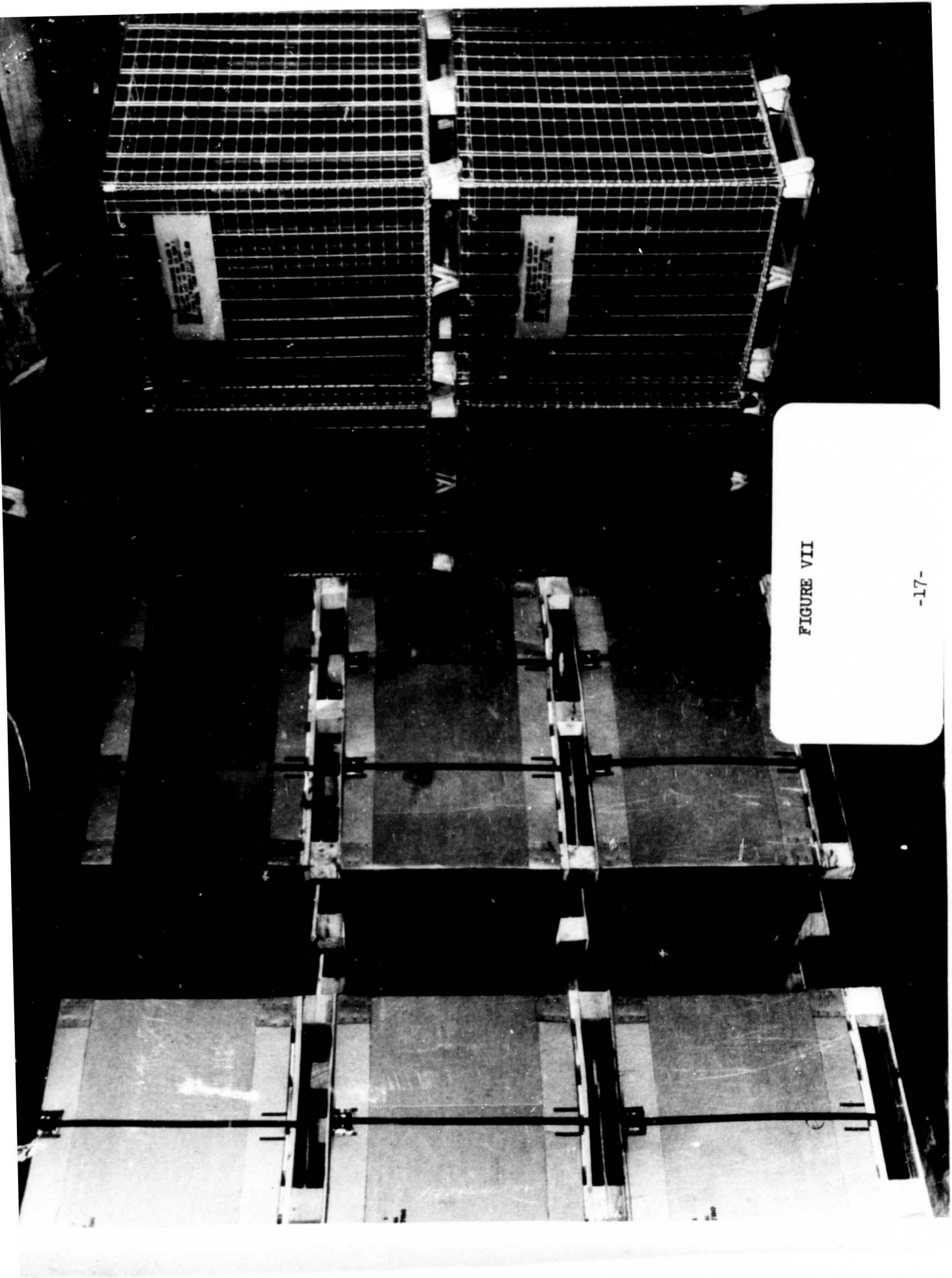


FIGURE VII

K. L. Warsop

SUN 143-10

1 August 1968

FIGURE VIIISUNFLOWER AAP EXPENDITURESPRON RI 8-A0262-01-FO-G3, DATED MAY 8, 1968**Labor:**

Salary ( 96 hours)	\$ 449	
Wage (431 hours)	<u>\$1,494</u>	<u>\$1,943</u>
Materials, purchased		\$ 695
Plant burden		<u>\$2,156</u>
Total		<u>\$4,794</u>

**Note:** Above labor includes special testing and unpacking; hence, the costs should not be compared with those given in Figure I.



Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) <b>Hercules Incorporated Sunflower Army Ammunition Plant Lawrence, Kansas 66044</b>		2a. REPORT SECURITY CLASSIFICATION -
		2b. GROUP -
3. REPORT TITLE <b>Evaluation of an Improved Shipping Container for MK 43 Mod 1 Propellant Grains</b>		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) <b>Final Report; February 1968 - July 1968</b>		
5. AUTHOR(S) (First name, middle initial, last name) <b>Kenneth L. Warsop</b>		
6. REPORT DATE <b>1 August 1968</b>	7a. TOTAL NO. OF PAGES <b>27</b>	7b. NO. OF REFS <b>None</b>
8a. CONTRACT OR GRANT NO. <b>DA-11-173-AMC-42 (A)</b>	9a. ORIGINATOR'S REPORT NUMBER(S) <b>143-10; 8-1-68</b>	
b. PROJECT NO. -		
c. -	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) -	
d. -		
10. DISTRIBUTION STATEMENT <b>Distribution of this document is unlimited.</b>		
11. SUPPLEMENTARY NOTES -	12. SPONSORING MILITARY ACTIVITY <b>Naval Weapons Handling Laboratory Earle, New Jersey</b>	
13. ABSTRACT <p>A one-trip, fibreboard, palletized, shipping container was tested as a replacement for the more expensive, currently used combination of shipping tubes packed in metal cargotainers. If proven and adopted, the proposed shipping container would return annual savings of half a million dollars at the present rate of shipments from Sunflower AAP. On-plant tests involving 12,000 propellant grains gave encouraging results, but permission to undertake off-plant evaluation was refused.</p>		

DD FORM 1473  
1 NOV 65

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS  
OBSOLETE FOR ARMY USE.

Unclassified

Security Classification

Unclassified

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Shipping Container Propellant Grains						

Unclassified

Security Classification